REMARKS

Claims 2 and 4 were pending. Claims 2 and 4 were rejected. Claims 2 and 4 are being cancelled. Claims 6 – 11 (claims 6 and 9 correspond to claims 2 and 4, respectively) are being added. Reconsideration is respectfully requested.

Claim Objections

The Examiner objected to claim 2 because of an informality. Rewritten claim 6 has amended the term screening to filtering for purposes of clarity.

Claim Rejections – 35 U.S.C. §112

The Examiner rejected claims 2 and 4 under 35 U.S.C. §112, first paragraph, as failing to comply with the written description requirement; specifically that the claims contain subject matter that was not described in the specification in such a way as to reasonably convey to one skilled in the art that inventor had possession of the claimed invention at the time of filing. Applicants traverse.

The Examiner contends that the specification does not describe which particular toxic materials are detected. However, use of Cr^{6+}, mercury (Hg), lead (Pb), and phenol standard solutions as toxic materials are disclosed in the exemplary embodiments of the present invention. Therefore, the toxic materials disclosed in the present invention means the materials containing heavy metals that are harmful to a human body. Further, claims 6 and 8 are being added specifically reciting these toxic materials.

The "electrochemically active bacteria" recited in the claims generally refer to a microorganism reducing metal salts that serve as oxygen under anaerobic conditions, and growing. Until now, research into the kinds of electrochemically active bacteria has been underway, and "Shewanella pyutrefaciens (Microorganism Deposit No. KCTC 8753P)" may be a representative example.

Examining the structures of these microorganisms, a cytochrome that is an important electron transfer protein of an electron transport system is in an outer membrane, and particularly, an active site of the cytochrome is protruded outward from a microorganism. As a result, the microorganisms directly transfer electrons generated in the process of dissolving organic

materials to external metal salts through the cytochromes by directly binding to large metal salts that externally exist, and reducing equivalents thereof are used for the growth of the microorganisms (refer to U.S. Patent No. 5,976,719).

That is, unlike general microorganisms, these microorganisms are electrochemically activated by externally exposed cytochromes, and thus are generally named as electrochemically active bacteria or electrochemically active microorganisms. Therefore, it is not reasonable to restrict these microorganisms to specific microorganisms like the scope of a strain patent. This would have been easily understood by one of ordinary skill in the art.

The Examiner contends that Claim 2 is indefinite. Thus, the applicant added the term "corresponding to the presence of toxic material" to thereby clarify the scope of Claim 6, which corresponds to claim 2.

Claim Rejections – 35 U.S.C. § 103

The Examiner rejected claim 2 as being unpatentable over Evans et al. (hereinafter D1) in view of USPN 5,976,819 to Kim et al. (hereinafter D2). Claim 4 was rejected as being unpatentable over D1 in view of D2 and further in view of USPN 5,160,604 to Nakamura et al. (hereinafter D3) and USPN 6,058,763 to Shedd et al. (hereinafter D4). Applicants traverse.

I. Differences between the Claimed Invention and D1

D1 discloses ASRIT (Activated Sludge Respiration Inhibition Test) and it relates to a system monitoring toxicity by getting the signal of an electric current due to the inflow of toxic materials. It is characterised in using a 3-electrode system including a reference electrode, a counter electrode and a working electrode immobilizing an activated sludge or a lyophilised activated sludge to the surface of a working electrode with an Anopore fixed-microorganism membrane. However, it uses ρ-benzoquinone as a redox mediator, which can transfer an electron between the microorganisms and organic materials, and therefore it may discharge secondary pollutants and make it difficult to keep signal stability due to incompleteness of the fixed-membrane and difficulty of maintenance of the activated sludge, and it must be replaced within a few months.

Moreover, reference D1 discloses a plurality of different biosensors that are based on changes in the metabolic status of the cellular biocatalyst following challenge by environmental samples. These biosensors allow cellular redox events to be monitored continuously with the

amplitude of the biosensor signal, i.e. an electric current, being proportional to the level of metabolic activity of the biocatalyst.

Even though many of these biosensors are applied at an experimental stage it is difficult to transfer them to a system for automatically and continuously monitoring the water quality over a long period of time.

D1 further discloses a specific biosensor which is described in detail in section 2.2. This biosensor comprises a working electrode (anode) which is fitted with a porous material filled with activated sludge. These loaded electrodes are placed in a saline solution and provided with a respiratory solution.

In order to test a sample of water this electrode and a reference electrode are placed in a vial lid which also has a sample port for the addition of a mediator and toxicants.

Following a stabilization period of 5 to 10 min, a redox mediator is added by injection via the sample port. The response of the electrodes is monitored for at least 5 min to allow stabilisation of the electrode.

Subsequently, the sample is injected through the sample port and the biosensor responses are monitored over at least 30 min.

It is obvious to the person skilled in the art that this method refers to a batch mode that is not suited for continuously monitoring the water quality and rapidly detecting pollution.

Apparently the biosensor disclosed in D1 is designed for protecting an activated sludge from an overdose of toxic substances rather than monitoring the quality of drinking water. Accordingly, D1 uses a type of biosensor which differs from the inventive configuration in respect of the design of the cathode.

Further, there is no hint in D1 for an automated process or the design of an automated system. To the contrary, D1 teaches a batch mode which is carried out manually. This is evident from the fact that all electrodes and substances are introduced into a vial through a vial lid.

In conclusion, D1 fails to disclose not only the type of biosensor of the invention but also the layout for an automated method for continuously monitoring the water quality. Thus, D1 teaches away from the invention.

Accordingly, claim 6 is patentable over D1.

II. Differences between the Claimed Invention and D2

Conventional biofuel cells essentially use an artificial electron transfer mediator or sulfate as an electron transfer mediator. While the artificial electron transfer mediator promotes the efficiency of a fuel cell, it should be used in a limited amount since it is toxic to the microorganisms, and exerts adverse effects on microbial populations. In addition, the artificial electron transfer mediator may cause environmental problems when disposing of it after consumption. Even in a case where such an artificial electron transfer mediator is not used, there has been a problem that a specific metal which is not eroded by hydrogen sulfide should be used as an electrode when constructing a fuel cell since the reductive metabolic products (i.e., hydrogen sulfide) produced by a microorganism should be used as an electron transfer medium. To improve the drawbacks of the conventional cells, D2 provides a biofuel cell by employing metal salt reducing bacteria which can induce an efficient electrode reaction without an artificial electron transfer mediator.

However, a microbial fuel cell which effectively senses the changes in the current due to the entry of the toxic materials of waste water as claimed in the present invention is not disclosed at all in D2. The present invention may be regarded as equivalent to D2 in terms of microbial fuel cell. However, components of the present invention, i.e., a sample inlet pump (1) for taking a water sample and transferring it to the anode part; a microbial fuel cell (6) for sensing toxic materials and generating electrochemical signals; a pretreatment tank (2) for treating the water sample; means (10) for measuring electrochemical signals between the anode part and cathode part of the microbial fuel cell; a Personal Computer (PC) and controlling part (11) which control the value of the signals and automatically determine the toxicity of the water sample in response to changes in the signals due to the entry of the toxic materials; and a solenoid valve (5) and a sample-gathering vessel, said solenoid valve (5) being adapted to change the flow of water sample to the sample gathering vessel (4) when the entry of toxic materials into the microbial fuel cell (6) is sensed, are combined with each other to thereby constitute the device for detecting toxic material. Therefore, the present invention is completely different from D2 in terms of constitution.

III. Differences between the Present Invention and D3

D3 discloses a toxic substance-detecting device employing a microorganism sensor which combines a dissolved oxygen (DO) electrode and a fixed-microorganism membrane on which microorganisms are fixed disclosed in Evans' Invention. The microorganisms disclosed in D3 are nitrifying microorganisms such as nitrous acid-producing bacteria, and nitric acid bacteria. In the toxic substance-detecting device of D3, an amount of oxygen used in oxidizing ammonia contained in the test water is measured by the DO electrode, and the toxic substances are detected by changes in the consumed amount of oxygen according to existence of the toxic substances. Therefore, the device for detecting toxic materials through electrical signals of the electrochemically active bacteria in a sludge disclosed in the present invention is completely different from the device of D3 in terms of constitution. In the device of D3, it is difficult to stably maintain the system for a prolonged time period since the ammonia-contained test water (for maintaining the growth of the nitrifying microorganisms) should be periodically supplied, cultivation of the bacteria in a membrane is difficult, and the DO electrode should be continuously cleaned due to pollution of the DO electrode membrane and be periodically changed.

IV. Differences between the Present Invention and D4

D4 discloses an apparatus for monitoring water quality using the ventilatory behavior and body movement of aquatic organisms such as fishes. The system comprises electrodes for sensing electrical signals generated by the organism during ventilatory behavior and body movement in the water being monitored.

However, this system, in which the water quality is judged based on the behavior and health condition of fish, is defective in that the method is ambiguous and not suited for quantitative analysis, and factors which may affect behavior of the fish are not taken into account.

As D1 to D4 are related to completely different types of biosensors, a person skilled in the art would have never contemplated to combine these references and, moreover, even their combination would not have automatically resulted in the type of microbial fuel cell biosensor defined in claim 4. Further, it would have remained open as to how to implement the new biosensor into a method for monitoring the quality of water.

Thus, the teaching of the claims is neither anticipated nor rendered obvious by D1 to D4, whether considered independently or in combination.

As rejections have been overcome, Applicants submit that the application is in condition for allowance and request a Notice of Allowance be issued.

If the Examiner has any questions or needs any additional information, the Examiner is invited to contact the undersigned.

Respectfully submitted,
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